

Management of the OPAL Reactor Restart

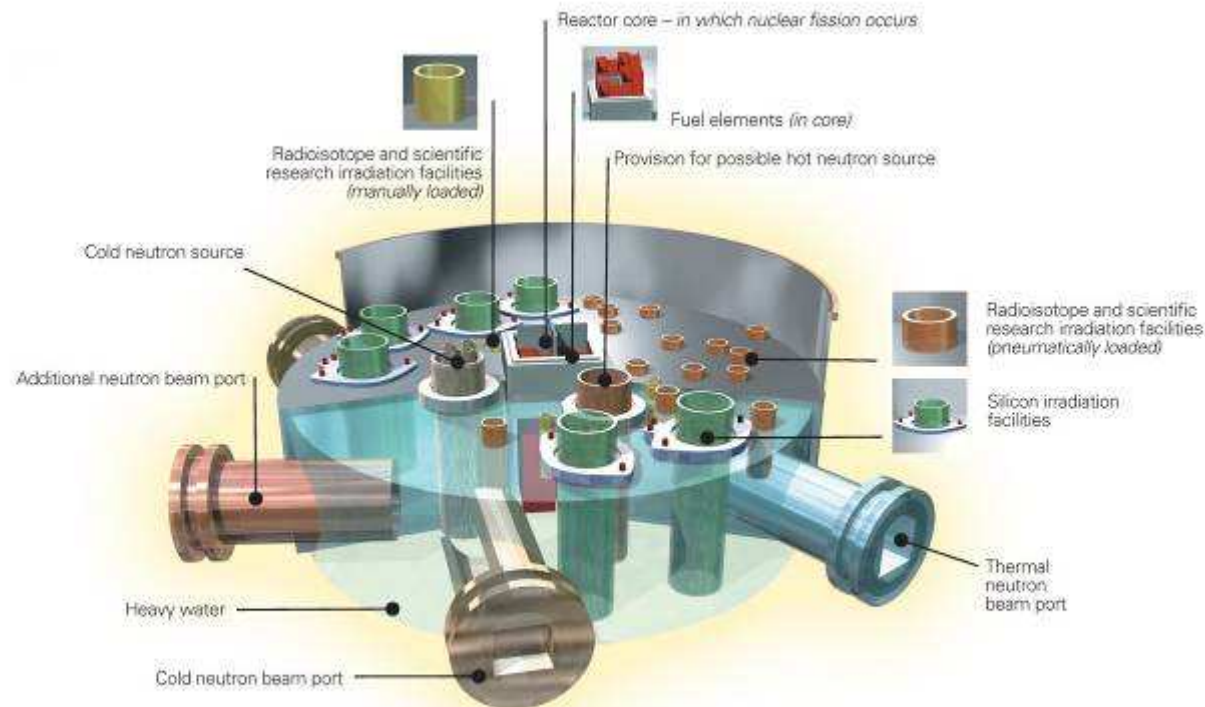
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OPAL Engineering & Maintenance
29 September 2009



Session 4: Reactor Operations

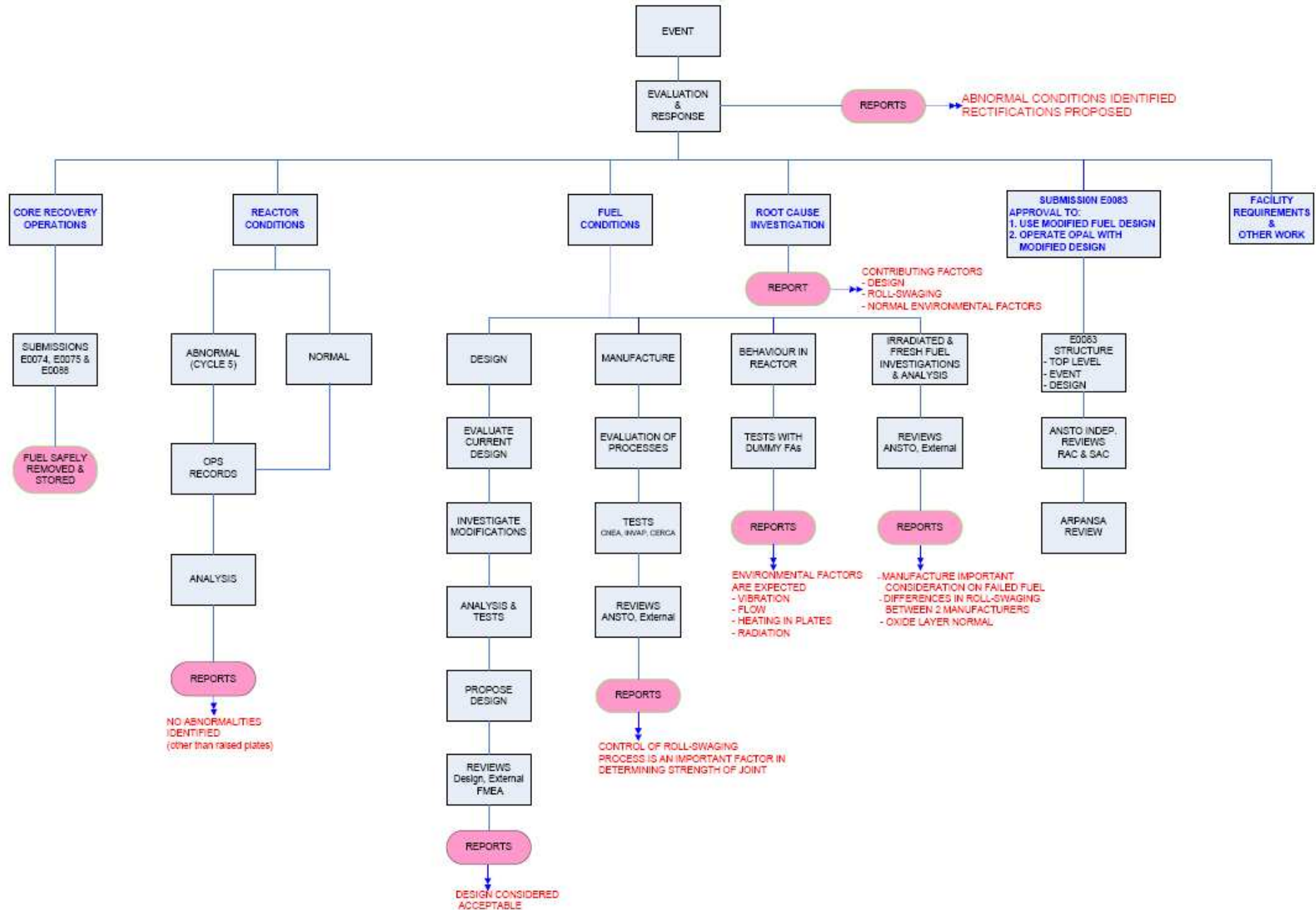
Introduction

- OPAL is located 40 km SW of Sydney. It is Australia's only reactor and is operated by ANSTO.
- Class: multipurpose research reactor
- First criticality: 12 August 2006



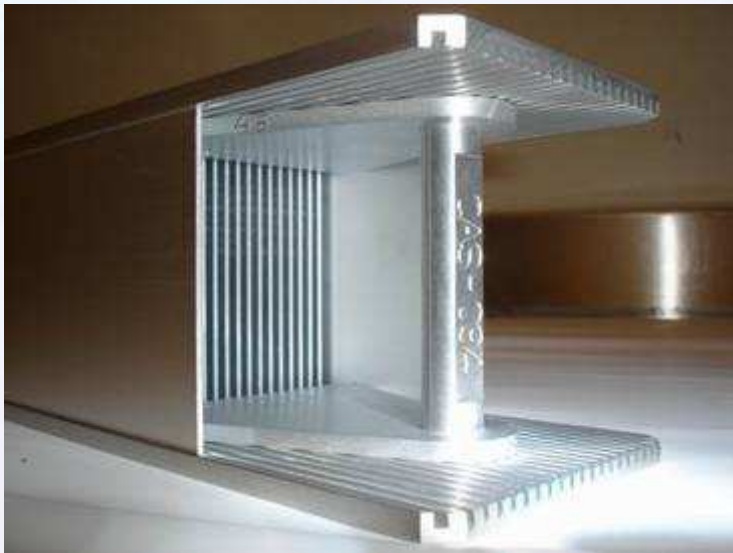
Type	Open Pool, 20 MW _t
Plate type fuel	U ₃ Si ₂ -Al dispersion
LEU	19.75%
Number/s	Plates: 21 FA: 16
Core dimensions, cm (LxWxH)	104.5 x 8.05 x 8.05
Control plates	5 hafnium (Hf)
Fluids	H ₂ O moderated D ₂ O reflector

APPENDIX: PROCESS CHART OF THE FUEL FAULT AND RECOVERY PROGRAM

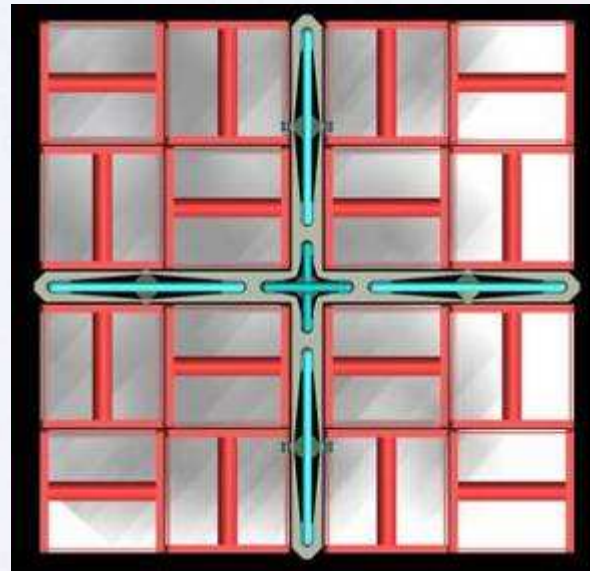


Event - Fuel Fault

- A displaced fuel plate was discovered on 24 July 2007 during post-refueling core inspection.
- No damage to fuel cladding (primary fission product barrier).
- Finalised as INES Level 1 event (24 Aug 2009).
- Fifth (5) cycle of operation.



FA: Modified fuel design



Core geometry

Management of the Restart - I

- **Outage work assessment (major projects)**

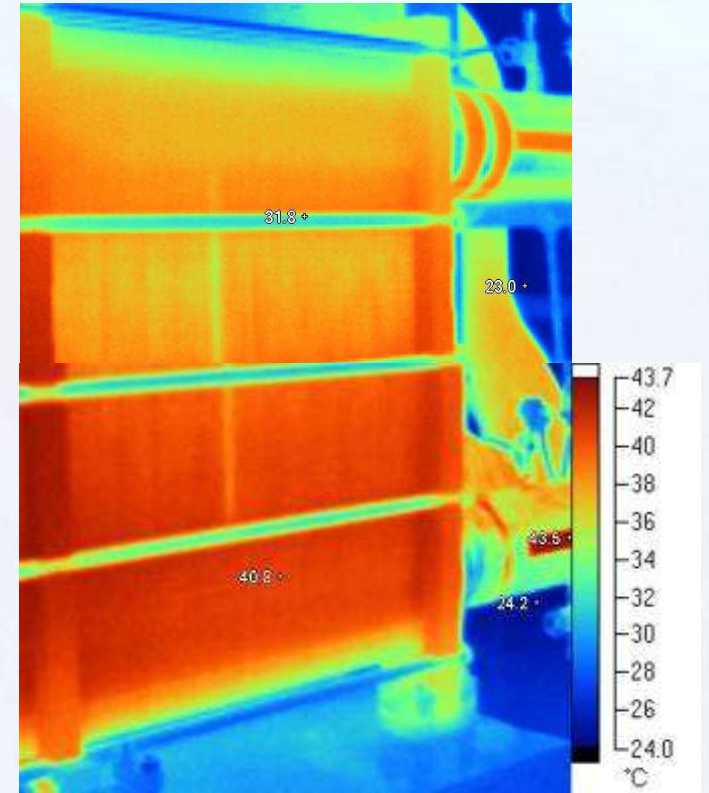
- Safe storage of FA with dislodged fuel plates
- In core dummy FA testing (flow / vibration / clamping force)
- Reflector Vessel leak testing / repair
- Reactor & Service Pool Drainage
- Control Rod seal-box replacement
- RCMS software update (Windows XP and I/A Version 7.1.3)
- CNS cryogenic sensor replacement / air leak repair
- Tritium (TRM 1 & 2) monitor repairs
- LN₂ supply tank upgrade
- UPS power supply upgrades
- FRPS logic modifications
- HWLS pump seal replacement and Rigs Cooling motor replacement
- Floor sealing and motor rewiring in the basement (L-5 and L-7)



Management of the Restart - II

- **Operational readiness**

- OPAL Operations staff
 - Minimum manning maintained
 - Simulator assessments to critical)
 - POWER state simulations
 - Emergency exercise drills
- Operational Limits and Condition compliance
 - SR maintained throughout shutdown
- Preventative / corrective maintenance up to date



Management of the Restart - III

- **Development of restart instructions**

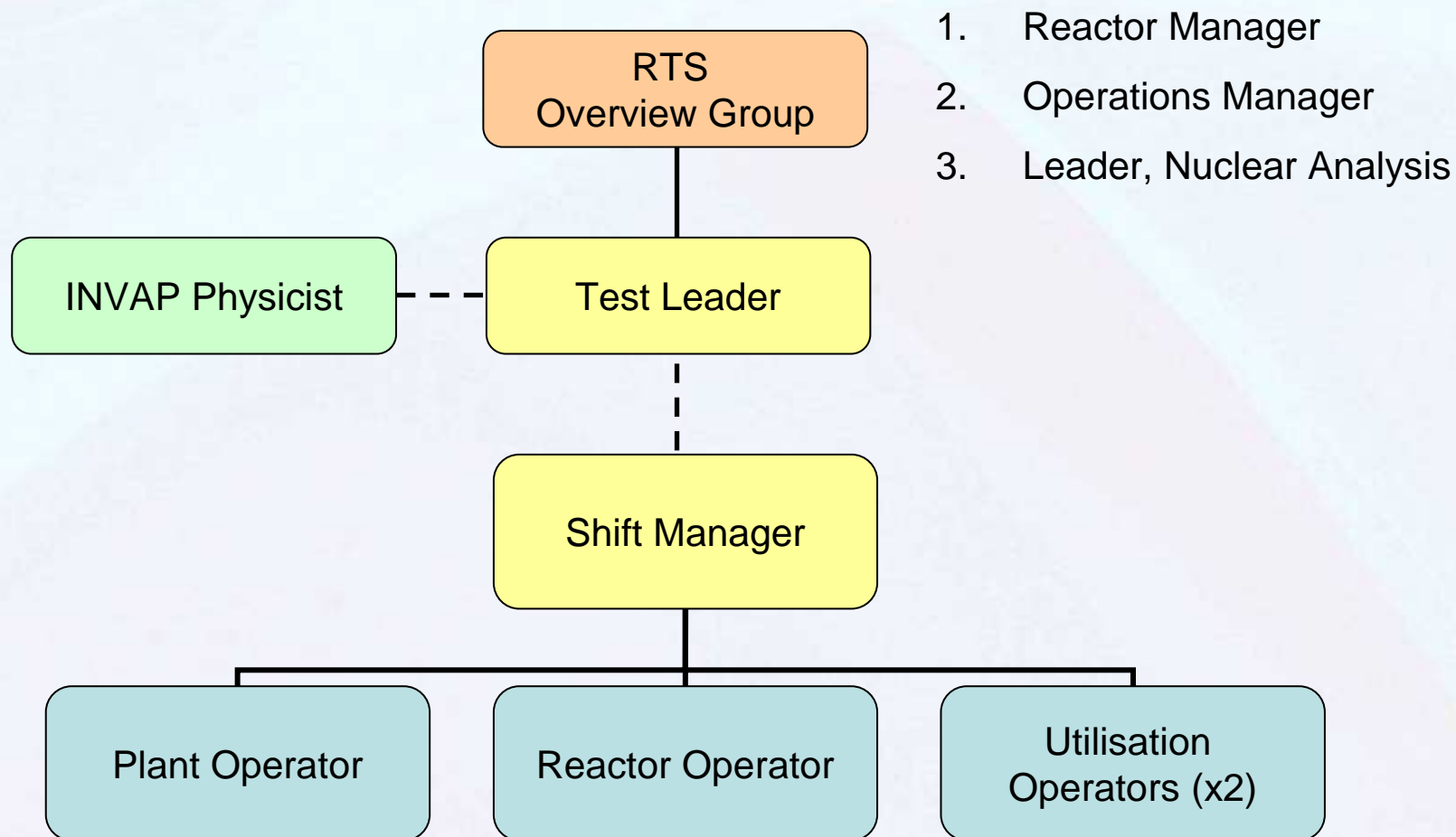
- Required for activities and tests to load fuel, test modified design, achieve criticality, raise power incrementally to 20 MW_t
- Based upon Stage B1/B2/C Hot Commissioning procedures
- 23 instructions modified / reviewed / approved for restart in OPAL ISO 9001 quality system

- **Return to service strategy**

- Instructions run by a responsible officer and carried out by authorised shift staff
- Implementation overseen by the *Return to Service Overview Group*
- New fuel design → un-irradiated start-up core required
- Fuel management strategy = CORE 1 repeat



Management Structure



Restart Sequence

Verification of Prerequisites

Set-up of Safety System Settings

TRIP 1 Test

Prelim. FC Calibration

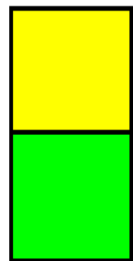
First Reactor Core Fuel Loading

Approach to Criticality

Shutdown Margin Measurement

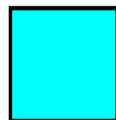
A1	B1	C R 1	C1	D1
A2	B2		C2	D2
CR 2		CR5	C R3	
A3	B3	C R 4	C3	D3
A4	B4		C4	D4

A1	B1	C R 1	C1	D1
A2	B2		C2	D2
CR 2		CR5	C R3	
A3	B3	C R 4	C3	D3
A4	B4		C4	D4

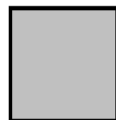


~212 g U^{235} /FA without BP

~383 g U^{235} /FA with BP



~484 g U^{235} /FA with BP
standard type

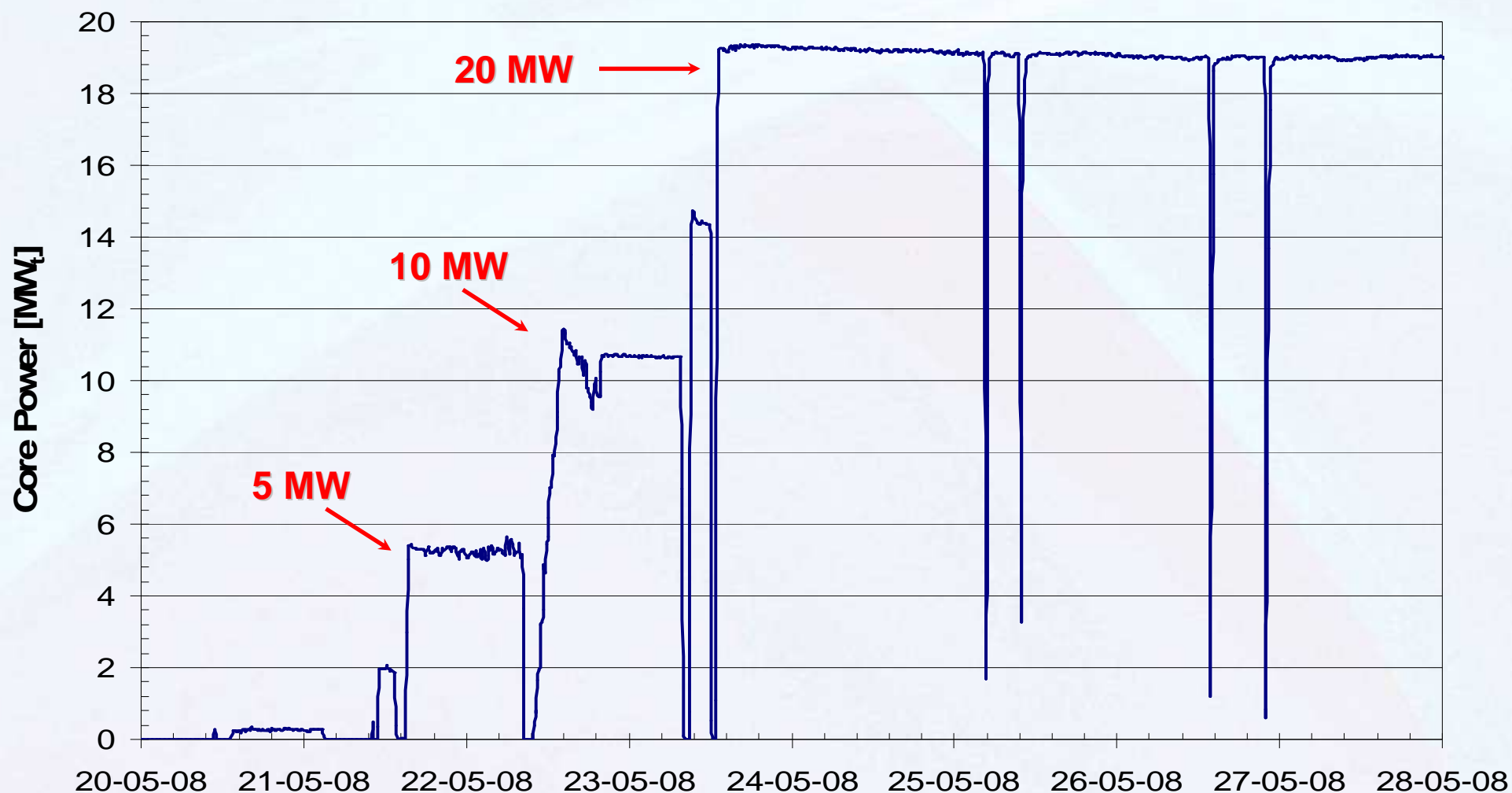


Neutron Source

Ansto

Nuclear-based science benefiting all Australians

Power Ascension Testing



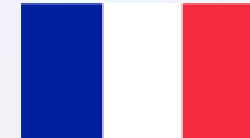
1. Core DP Measurement Testing
2. CR Calibrations
3. Nucleonic Power Calibrations
4. Power Performance Tests

Lessons Learnt

- Results of commissioning and past experience gained → key in enabling a smooth restart.
- Improved surveillance program for fuel inspections was required (pre/post irradiation) at ANSTO.
- New detailed inspections of fuel batches at the point of manufacture established.
- OPAL fuel specification modified to include a pull-test to assess swaging strength.
- Regulatory and stake-holder engagement are key in managing a successful restart following reactor technical difficulties.
- There was significant benefit from information exchange and review of the fault by other (international) nuclear operators.

Acknowledgements

- ANSTO
 - OPAL Management
 - OPAL Operations / Utilisation
 - OPAL Eng. & Maintenance
 - Nuclear Analysis Section (NAS)
 - Safety & Reliability Section (SRS)
 - Institute of Materials Engineering (IME)
 - Reactor Assessment Committee (RAC)
 - Safety Assessment Committee (SAC)
- Defence Science & Technology Organisation (DSTO)
- INVAP and CNEA (Argentina)
- CERCA (Areva - France)
- Expert Review Team (INL - US, NRG - Netherlands)
- ARPANSA (Australian Nuclear Regulator)



Questions

